UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|---|---|---|---|
| 09/863,224 | 05/24/2001 | Ming-Hsing Tsai | TS00-563 | 9872 |

28112 7590 07/27/2004

GEORGE O. SAILE & ASSOCIATES
28 DAVIS AVENUE
POUGHKEEPSIE, NY 12603

| EXAMINER | |
|---|---|
| TOLEDO, FERNANDO L | |
| **ART UNIT** | **PAPER NUMBER** |
| 2823 | |

DATE MAILED: 07/27/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. | Applicant(s) |
|---|---|---|
| | 09/863,224 | TSAI ET AL. |
| | Examiner | Art Unit |
| | Fernando L. Toledo | 2823 |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *16 May 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-30* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22,25,26 and 28-30* is/are rejected.

7)☒ Claim(s) *23,24 and 27* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 May 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Claim Rejections - 35 USC § 102*

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1 – 12 are rejected under 35 U.S.C. 102(e) as being anticipated by Chen et al. (U. S. patent 6,518,166 B1).

In re claim 1, Chen in the U. S. patent 6,518,166 B1; figures 1 – 7 and related text discloses providing a substrate (Column 6, Lines 11 – 13) having a first insulative layer 3 and a second insulating layer 5 separated from each other by an intervening etch-stop layer 4 formed therein the substrate; forming a hole opening 7 in the first and second insulative layers, including the intervening etch-stop layer; forming a low-k protection layer 8a over the second insulating layer, including in the hole opening, wherein the low-k protection layer prevents outgassing from the first and second insulative layers (Column 3, Lines 26 – 35); forming a trench opening 10a over the hole opening to form a dual damascene structure, the hole opening containing the low-k dielectric layer (Figure 5); forming a barrier layer on the vertical walls of the trench opening on the low-k protection layer on the vertical walls of the hole opening (Column 5, Lines 54 – 58); forming a metal layer 12/13 on the barrier layer in the dual damascene structure; and performing CMP to complete the forming of the dual damascene structure (Column 5, Lines 61 – 64).

3. In re claim 2, Chen discloses wherein the first insulative layer is a low-k dielectric having a dielectric constant between 2.0 – 3.0 (Column 3, Lines 43 – 47).

4. In re claim 3, Chen discloses wherein the first insulative layer has a thickness between about 2000 to 100000Å (Column 3, Lines 43 – 47).

5. In re claim 4, Chen discloses wherein the intervening etch-stop layer is silicon nitride (Column 3, Lines 47 – 48).

6. In re claim 5, Chen discloses wherein the intervening etch-stop layer has a thickness between about 50 to 1000Å (Column 3, Line 49).

7. In re claim 6, Chen discloses wherein the second insulative layer is a low-k dielectric having a dielectric constant between about 2.0 to 3.0 (Column 3, Lines 43 – 47).

8. In re claim 7, Chen discloses wherein the second insulative layer has a thickness between about 2000 to 100000Å (Column 3, Lines 55 – 57).

9. In re claim 8, Chen discloses wherein the low-k protection layer includes $SiO_2$, SiN, SiC, or SiNC (Column 4, Line 62).

10. In re claim 9, Chen discloses wherein the low-k dielectric protection layer has a thickness between 20 to 1000Å (Column 4, Line 63).

11. In re claim 10, Chen discloses wherein the barrier layer material is selected from the group including Ta, Ti, TaN, TiSiN, TaSiN or WN (Column 5, Line 56).

12. In re claim 11, Chen discloses wherein the barrier layer has a thickness between about 30 to 500Å (Column 5, Line 58).

13. In re claim 12, Chen discloses wherein the metal includes copper (Column 5, Line 62).

***Claim Rejections - 35 USC § 103***

14. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

15. Claims 13 – 22, 25, 26 and 28 – 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen in view of Zhou (U. S. patent 6,358,842 B1).

In re claim 13, Chen discloses providing a substrate (Column 6, Lines 11 – 13) with a metal layer 2 formed on the substrate; forming a first insulative layer 3; forming an etch-stop layer 4 over the first insulative layer; forming a second insulative layer 5 over the etch-stop layer; forming a first photoresist 6 layer over the second insulative layer and patterning the photoresist to form a first photoresist mask having a hole pattern (Figure 2); etching the first and second insulative layers, including the etch-stop layer through the hole pattern to form a hole opening in the first and second insulative layers (Figure 2); removing the first photoresist mask (Figure 4); forming a low-k protection layer in the hole opening in the first and second insulating layers, including over the substrate (Figure 4); forming a second photoresist layer over the substrate, including over the hole opening having the low-k dielectric protection layer and patterning the second photoresist to form a second photoresist mask 9 having a trench pattern (Figure 5); etching the second insulating layer through the trench pattern in the second photoresist mask to form a trench in the second insulating layer, thus completing the forming of the dual damascene structure in the substrate (Figure 6); removing the second photoresist; removing the low-k protection layer form over the substrate and from the bottom of the hole

opening while leaving the low-k dielectric layer on the vertical sides of the hole opening; exposing the underlying first metal layer (Figure 7); forming a barrier layer over the substrate, including the dual damascene structure, wherein the barrier layer conforms to the low-k protective layer in the hole opening and conforms to the trench in the second insulative layer (Column 55 – 58); depositing a second metal 12/13 over the barrier layer in the dual damascene structure; and performing CMP to complete the forming of the dual damascene structure (Column 5, Lines 61 – 64).

Chen does not disclose forming a barrier layer. However, Zhou, in the U. S. patent 6,358,842 B1; figures 1 – 13 discloses forming a barrier layer 58 to prevent out diffusion of copper from the copper conductors (Column 4, Lines 11 – 13).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to form a barrier layer in the invention of Chen, since, as taught by Zhou, the barrier layer prevents out diffusion of copper from the copper conductors.

16. In re claim 14, Chen does not disclose wherein the substrate is silicon. Zhou discloses wherein the substrate 50 is made of silicon.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have the substrate of Chen made of silicon, as taught by Zhou, since it has been held to be within the general skill of a worker in the art to select a known material on the base of its suitability, for its intended use involves only ordinary skill in the art. *In re Leshin*, 125 USPQ 416.

17. In re claim 15, Chen in view of Zhou discloses wherein the passivation layer includes silicon nitride (Column 4, Lines 12 – 14 of Zhou).

18. In re claim 16, Chen in view of Zhou discloses wherein the passivation layer has a thickness between 30 to 1000 Å (Column 4, Lines 12 – 15 of Zhou).

19. In re claim 17, Chen discloses wherein the first insulative layer is a low-k dielectric having a dielectric constant between 2.0 – 3.0 (Column 3, Lines 43 – 47).

20. In re claim 18, Chen discloses wherein the first insulative layer has a thickness between about 2000 to 100000Å (Column 3, Lines 43 – 47).

21. In re claim 19, Chen discloses wherein the intervening etch-stop layer is silicon nitride (Column 3, Lines 47 – 48).

22. In re claim 20, Chen discloses wherein the intervening etch-stop layer has a thickness between about 30 to 1000Å (Column 3, Line 49).

23. In re claim 21, Chen discloses wherein the second insulative layer is a low-k dielectric having a dielectric constant between about 2.0 to 3.0 (Column 3, Lines 43 – 47).

24. In re claim 22, Chen discloses wherein the second insulative layer has a thickness between about 2000 to 100000Å (Column 3, Lines 55 – 57).

25. In re claim 25, Chen discloses wherein the low-k protection layer includes $SiO_2$, SiN, SiC, or SiNC (Column 4, Line 62).

26. In re claim 26, Chen discloses wherein the low-k dielectric protection layer has a thickness between 30 to 1000Å (Column 4, Line 63).

27. In re claim 28, Chen discloses wherein the barrier layer material is selected from the group including Ta, Ti, TaN, TiSiN, TaSiN or WN (Column 5, Line 56).

28. In re claim 29, Chen discloses wherein the barrier layer has a thickness between about 30 to 500Å (Column 5, Line 58).

29. In re claim 30, Chen discloses wherein the metal includes copper (Column 5, Line 62).

### *Claim Objections*

30. Claims 23, 24 and 27 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

### *Response to Arguments*

31. Applicant's arguments with respect to claims 1 – 30 have been considered but are moot in view of the new ground(s) of rejection.

### *Conclusion*

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Fernando L. Toledo whose telephone number is 571-272-1867. The examiner can normally be reached on Mon-Thu 7am to 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

George Hourson
Primary Examiner
Art Unit 2823

FToledo
22 July 2004